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Such has been the progress of zoölogy in the United States within less than a century. Its future progress will in part depend on the attention paid to it by medical students, to whom we may look for treatises on histology and embryology. At present there are no histologists in the United States who have published special monographs. When professorships of zoölogy alone are established in our colleges (at present mineralogy, botany, zoölogy, and geology are often taught by a single person) competent science-teachers will arise for our higher schools, and the science, we may hope, will be cultivated with something of the thoroughness of the German methods. At present we are not so greatly behind France and England as we were twenty years ago. There is, however, danger that Russia will outstrip us, and we are about on a level with the Scandinavians and the Dutch.

With our energy and native ability, and the aid of well-endowed colleges and museums, we may hope hereafter to compete even with Germany. The development of any branch of science is largely dependent on individual students, and every opportunity should be afforded young men of promise of devoting their time to original research. Specialists are sadly wanted in a country like ours, where the tendency is, perhaps, rather to the production of mediocrity than of genius.

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THE MISSING LINK BETWEEN THE VERTEBRATES AND INVERTEBRATES.[1]

THE views which Dr. Dohrn has recently put forth, as to the details of the steps by which the vertebrate stock arose out of an ancestry not very much unlike the existing Annelids, are of such interest that, notwithstanding previous reference to the subject, no apology is needed for presenting the readers of *Nature* with a condensation of the main argument contained in The Origin of Vertebrata.

Dr. Dohrn first draws attention to the correspondences between vertebrate and insect embryos, which have been too little regarded in consequence of our designating the nervous side in the one as dorsal, in the other as ventral. Yet the facts that, in both, the nervous system is developed on the convex side of the embryo and acquires a strong convex flexure anteriorly, and that the body-cavity is finally closed up on the side of the body opposite to the nervous system, point to a common origin at a comparatively high level. The surface of the animal which is called ventral is determined by the presence of the mouth on that surface; and if any vertebrates had a mouth-opening between the brain and the spinal cord on the dorsal surface, that dorsal surface would necessarily become ventral. Since, moreover, the ancestors of the vertebrata must have had a nervous ring surrounding their gullet, it would appear more reasonable to suppose that the mouth-opening had been changed in the course of development than that the situation of the nervous centres had been altered. We are thus led to look for traces of an old mouth-opening on that surface of the early vertebrates which corresponded to our dorsal surface, and to seek reasons for regarding our present mouth as a comparatively modern development.

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[1] Der Ursprung der Wirbelthiere und das Princip des Functionwechsels: Genealogische Skizzen. Von Anton Dohrn. (Leipzig: Engelmann.)

Dr. Dohrn believes that the old mouth passed through the nervous centres between the crura cerebelli, or, more accurately, in the fossa rhomboidea, or fourth ventricle, which is remarkable for being of greater proportionate size early in development, and afterwards undergoing retrogression. At an early stage we only need to conceive a slit to be made in the nerve tube at the bottom of the fossa rhomboidea, in order to furnish a suitable passage into the alimentary canal. His first reason for regarding the vertebrate mouth as a modern structure is that it arises so extraordinarily late in development. The embryonic body is almost completely framed, all the great systems are established, the circulation is in active operation, while as yet there is no mouth. Again, the mouth does not arise in the position in which it permanently remains in the great majority. It undergoes considerable shifting forwards. Only in the Selachians and Ganoids does it retain its primitive situation. Moreover, the study of development is steadily tending to establish the idea that the mouth of vertebrates is homodynamous with the gill-clefts. It is limited, like them, by a pair of arches, lies just in front of the first pair of gill-clefts, arises simultaneously with them in the embryo, and opens into the alimentary canal. A glance at the ventral surface of a Ray shows the likeness of the mouth to a pair of coalesced gill-clefts. Consequently, it becomes probable that the present mouth-opening once existed and functioned as a gill-cleft; that at a certain period in the ascending development, both the old and the new mouths supplied nourishment, that the latter gained the predominance, and that finally the old mouth became aborted.

The next problem attacked is the origin of the gill-clefts. A very elaborate account is given of the supposed process by which the external gills and segmental organs of Annelids were metamorphosed into the gills and gill-clefts of vertebrates and the skeletal elements connected with them. The great difficulty which Dr. Dohrn confesses in this matter is the connection of the inner extremities of the segmental organs with the wall of the alimentary canal. But if this be granted it is comparatively easy to understand how the shortening and widening of the segmental organs might give rise to gill-cavities such as those of the Selachians. The process by which Dr. Dohrn conceives that the limbs of vertebrata might have been developed from two pairs of gills in Annelids is a greater evidence of ingenuity, though it is to be expected that it will be viewed rather incredulously.

It follows from the view of the origin of vertebrates thus expounded that Amphioxus loses much of its interest, for there is no place for Amphioxus among Annelids, nor among the primordial vertebrates; it lacks almost all that they possess. Yet nothing can be gained by excluding Amphioxus from the vertebrates; for it is so connected with the cyclostome fishes that it cannot be placed at any great distance from them; while on the other hand it is so related to Ascidians that the latter must be included among the vertebrata.

Dr. Dohrn then proceeds with a long argument to show that the cyclostome fishes are degenerate from a higher type of fishes, and that Amphioxus is a result of still further degeneration. He shows how their mode of life necessitates many of the modifications they have undergone, and that the diversities of the details of structure in cyclostomes are inconsistent with their being viewed as representing stages in upward development. Finally, the larva of Ascidians is represented as a degenerate fish — a degenerate cyclostome, possibly — which carries to the extreme all the departures of the latter from the fish-type. The most important element in this degeneration results from the fact that Ascidians, instead of being attached to fishes or to any objects from which they can derive nutriment, are fixed to stones, plants, etc., or to such parts of animals (cephalo-thorax of crabs, tubes of tubicolous annelids) as do not afford them nourishment. Consequently they have lost the old mouth in the organ of attachment, homologous with that of all vertebrates, and have developed a new one, homologous with the nasal passage of *Myxine.* Thus we can explain the astonishing fact that the mouth-opening of the Ascidian larva has a communication with the fore-wall of the so-called cerebral vesicle. It is the last vestige of the openings in the nasal sacs by which the olfactory nerves entered.

The most patent objection to Dr. Dohrn's view about Amphioxus is that it fails to account for the development of a many-segmented respiratory apparatus as a degeneration from a higher animal with a small number of gill-arches. It would appear far more reasonable to suppose Amphioxus to be a degeneration from a much lower elevation than the cyclostome type, namely, from some stage where the respiratory apparatus retained the multiserial character derived from its Annelid forefathers.

The key-note of the author's reasonings is to be found in the principle of transformation of function (*Functionswechsel*), on which he lays great stress. He states it as follows: The transformation of an organ happens through a succession of functions being discharged by one and the same organ. Each function is a resultant of several components, of which one constitutes the chief or primary function, while the others are lower or secondary functions. Diminution of the importance of the chief function with increase of the importance of a secondary function alters the entire resultant function; the secondary gradually rises to be the chief function, the resultant function becomes different, and the consequence of the whole process is the transformation of the organ. This principle is considered to be a complete answer to the difficulty so strongly insisted on by Mr. Mivart, the incompetency of natural selection to account for the incipient stages of subsequently useful structures. Dr. Dohrn's statement of his principle does not strike us as very different from Mr. Darwin's (Origin of Species, fifth edition, page 251), though a little more definitely stated. Mr. Darwin says, "The same organ having performed simultaneously very different functions, and then having been in part or in whole specialized for one function; and two distinct organs having performed at the same time the same function, the one having been perfected whilst aided by the other, must often have largely facilitated transitions." The illustrations given by Dr. Dohrn of the steps by which the anterior extremities of crustacea became applied to mastication, how the mouth of vertebrates originated from a pair of gill-clefts, how the respiratory apparatus of tunicates originated from that of vertebrates, etc., are, however, exceedingly interesting.

An English translation of Dr. Dohrn's pamphlet could not fail to be serviceable to the large number of students who take an interest in the genealogical problems of morphology. — G. T. Bettany, in *Nature*.

A COSMOPOLITAN BUTTERFLY. II. ITS HISTORY.

BY SAMUEL H. SCUDDER.

NOTWITHSTANDING the ubiquity and general abundance of *Vanessa cardui*, its natural history is imperfectly known. Of its life in the tropics there is no published statement beyond the brief account given by the indefatigable Horsfield; he simply mentions that in Java the caterpillar feeds on a species of *Artemisia*, the native name of which is *Godomollo*, and that the butterfly appears in December. Just beyond the tropics, at the Cape of Good Hope, Trimen reports it as found in the imago state throughout the year, but most abundant from September to March. At about an equal distance north of the tropics, on the same continent, in Egypt, this butterfly flies through the winter, and from November to March caterpillars in almost every stage may be found upon a species of *Malva*, called by the Arabs *Mlukheh*, while the thistles growing abundantly by the railway lines are untouched. These fragments comprise the account of this butterfly outside of Europe and North America, and the following remarks are confined to this insect as it exists in north temperate regions.

In New England this butterfly is double-brooded and hibernates in the imago state.[1] The hibernating butterflies do not usually begin to emerge from their winter quarters until the middle of May, and badly worn specimens continue to fly until after the middle of June. They lay their eggs during the latter half of May and early in June; these hatch in from six to eight days, and the caterpillars therefrom become fully grown between the middle of June and the middle of July; the chrysalids hang from eight to fourteen days, and disclose the first fresh butterflies about the 10th of July. These usually become abundant by the middle of the month, and at the end of the third week innumerable; they continue to emerge from the chrysalis until the early days of August, and fly until the next brood appear; these lay their eggs during the last of July and first of August, and the caterpillars

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[1] At least so far as is known. In Europe, according to some writers, it often passes the winter in the chrysalis state; but authorities do not agree upon this point.